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Engineering Institute Presentation

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"Wireless Sensing Systems for Health Monitoring and Control of Civil Structures"

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Abstract: The common deterioration of civil infrastructure systems and the threat of extreme loadings require facility managers to improve their knowledge regarding the health of the structures that they manage. A dense array of wireless sensors installed in a structure could provide ample amounts of empirical data for monitoring structural health. In addition to being a low cost alternative to traditional cable-based monitoring systems, wireless sensor networks offer a distributed computing paradigm that allows sensors to self interrogate structural response data in real-time. Various field validation studies have been performed using wireless sensor network architectures under development at the University of Michigan. In this talk, the New Carquinez Bridge (Vallejo, CA) which is monitored using a dense network of wireless sensors is presented in detail. Sensors are responsible for recording the response of the bridge to traffic loading. Furthermore, the wireless sensor network conducts in-network system identification analyses to estimate modal parameters of the bridge. In recent years, substantial research has been conducted to advance structural control as a direct means of mitigating the dynamic response of civil structures. To reduce the labor and costs associated with installing extensive lengths of coaxial wires in today's structural control systems, wireless sensors are being considered as building blocks of future systems. In the proposed system, wireless sensors are designed to perform three major tasks in the control system; wireless sensors are responsible for the collection of structural response data, calculation of control forces, and issuing commands to actuators. In this study, a wireless sensor is designed to fulfill these tasks explicitly. However, the demands of the control system, namely the need to respond in real-time, push the limits of current wireless sensor technology. The wireless channel can introduce delay in the communication of data between wireless sensors; in some rare instances, outright data loss can be experienced. To validate the performance of a prototype wireless control system, shaking table experiments are carried out on a six story steel structure in which magnetorheological (MR) dampers have been installed for real-time control. In comparison to a cable-based control system installed in the same structure, the performance of the wireless control system is shown to be effective and reliable.

Biography: Jerry is an Assistant Professor of Civil and Environmental Engineering (Electrical Engineering and Computer Science by courtesy) at the University of Michigan. His current research interests are in the areas of wireless sensor networks, MEMS accelerometers, structural monitoring, active sensing, damage detection and decentralized structural control algorithms. He completed his graduate studies at Stanford University where he received his PhD in Civil and Environmental Engineering in 2002, MS in Civil and Environmental Engineering in 1998, and MS in Electrical Engineering in 2003. Jerry has work experience in the structural engineering and embedded system fields after spending time with Weidlinger Associates in New York City and SC Solutions in Santa Clara. Jerry is a recipient of 2005 Navy your research investigator for his research in wireless sensing networks. He is also co-founder of Sensametrics, Inc. in 2001.

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